NAVAL POSTGRADUATE SCHOOL
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THESIS

CONTAINER ACQUISITION IN THE NAVY

by

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December 1982

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This thesis examines the containerization needs of the U.S. Navy precipitated by the recall of Army-owned military vans (MILVANS) currently supporting four Naval logistics pipelines in the Pacific. A brief history of containerzation is followed by a discussion of the types of containers in use, the international standards applied to them, and the advantages of the through concept of containerization. The

development of military-owned standard containers and containerized cargo movement within the military are then discussed. After the evolution and definition of the problem are presented, viable alternatives for replacing lost MILVAN assets are analyzed. In the process, a framework for analysis is developed that can be further effectively employed by decision makers as desired. In the final chapter, specific conclusions and recommendations are presented regarding the alternatives evaluated.

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Container Acquisition in the Navy

by

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ABSTRACT

This thesis examines the containerization needs of the U.S. Navy precipitated by the recall of Army-owned military vans (MILVANS) currently supporting four Naval logistics pipelines in the Pacific. A brief history of containerization is followed by a discussion of the types of containers in use, the international standards applied to them, and the advantages of the through concept of containerization. The development of military-owned standard containers and containerized cargo movement within the military are then discussed. After the evolution and definition of the problem are presented, viable alternatives for replacing lost MILVAN assets are analyzed. In the process, a framework for analysis is developed that can be further effectively employed by decision makers as desired. In the final chapter, specific conclusions and recommendations are presented regarding the alternatives evaluated.

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I. INTRODUCTION

The military vans (MILVANS) presently in use by the U.S. Navy are actually owned by and are on loan from the U.S. Army. Because of the pending implementation of the Army's containerized ammunition distribution system, these containers are being recalled by the Army. This recall is expected to be completed by September 1983 and would leave the Navy in a precarious position regarding containerized cargo movement if orderly container replacement is not accomplished in a timely fashion. For example, over three hundred Army-owned containers are currently in use in the Subic Bay-Diego Garcia logistics pipeline in support of Indian Ocean operations.

A. SCOPE OF THE THESIS

Because of the potential negative impact on material movement within the Navy caused by the Army's decision to recall its containers, this thesis examines the containerization needs of the Navy precipitated by this recall and attempts to determine the most cost-effective means to meet these needs. Hence, the objective of this thesis is to evaluate specific, viable alternatives to meet these needs and, in so doing, develop a framework for analysis that decision makers may effectively employ further, as desired.

B. PREVIEW OF THE THESIS

The following chapter introduces containerization by presenting its definition in today's parlance as well as its history. Chapter II also addresses container standardization, the various types of common containers and their uses, and major container handling equipment. Next, the advantages of this intermodal transportation method are discussed.

Chapter III turns toward a discussion of the development of the military-owned standard container and containerized cargo movement within the Department of Defense. After a brief overview of the Defense Transportation System, the role of the Military Sealift Command as the agency responsible for managing the military's sealift capability is presented. Chapter III concludes with the Department of Defense policy on container sealift.

Chapter IV provides the evolution and definition of the problem being analyzed: determining the most cost-effective means of replacing lost container assets.

Chapter V presents an overview of commercial ocean container acquisition. As such, this chapter serves as the foundation upon which alternative problem solutions will be built.

Chapter VI lists the alternative problem solutions evaluated and the criterion used for their ranking. A cost model is developed and exercised to yield the baseline costs of each alternative.

Chapter VII provides the results of a cost sensitivity analysis performed on the baseline costs of each alternative and establishes the relative importance of the cost components within the cost model.

Chapter VIII presents the conclusions and recommendations of this analysis.

II. INTRODUCTION TO CONTAINERIZATION

Containerization has been acclaimed a revolution in transport and is considered by some to be one of the most significant developments in the history of transportation:

> The application...of the unit load including containerization and palletization principle is almost as significant an advance in global economy as the transition from sail to steam, from wooden to iron ships. [Ref. 1: 46]

The evolution within the freight transportation industry toward containers has provided a significant impetus for change to the links of society. New methods of cargo shipment have been developed by those carriers accepting containerization as a more efficient means of material movement.

Railroads have been widely using standard size containers since the 1950's. Readily adopted by shippers and railroads, the concept of containers being attached to and detached from flatcars is the oldest form of containerized shipping.

Very few world-wide movements of containers are achieved without the service of truck lines, whether for a line-haul or for pickup and delivery service. Indeed, many truck lines have interchange agreements with shippers and other transport modes covering inland container movements.

Initiated by the Lockheed L-100 Hercules, the advent of the wide-bodied commercial aircraft extended the utilization of the standard container for cargo movement to the airline

industry. The use of wide-bodied commercial aircrafts as cargo transports has been closely tied to the airborne shipment of containers.

The use of containers, however, is perhaps most discernible within the maritime industry. Fleets of break-bulk ships are becoming obsolete. Shipyards have profited from contracts to convert break-bulk ships to containerships as well as to build ships exclusively for container cargo movement. Ports and exchange facilities have been converted or constructed based on the concept of containerization.

Container use is not restricted to the individual modes of rail, road, air and water. Standardization of the container, "...the rock on which container traffic is built" [Ref. 2: 597], has made it compatible with virtually any transportation mode and with nearly all container handling equipment. The container is clearly an intermodal and international device for the efficient movement of cargo.

A. CONTAINERIZATION DEFINED

Although containerization has been acclaimed a revolution in transport, the container is functionally no more than a box. In common with every other box, containers economize in the number of movements required to convey a given quantity of goods and afford these goods greater protection from damage and loss than they would otherwise receive. There are, however, two unique features of this particular box:

(1) it has been standardized for intermodal use, and (2) it is large; therefore, making the amount of transshipment required for any given amount of goods minimal. [Ref. 3: 11]

Containerization refers to the use of shipping containers in conjunction with other means of transport in the movement of goods. By this method, goods normally move from origin to destination without unloading or reloading. The term container, when used in connection with the containerization concept, refers only to those containers too large for manual handling, which are reusable, and which do not have wheels permanently attached. This particular definition excludes barrels, drums, vehicles, and conventional packing. More specifically, a freight container is an article of transport equipment:

1. Of a permanent character and accordingly strong enough to be suitable for repeated use;

2. Specially designed to facilitate the carriage of goods, by one or more modes of transport, without intermediate reloading;

3. Fitted with devices permitting its ready handling, particularly its transfer from one mode of transport to another;

4. Designed so as to be easy to fill and empty; and

5. Having an internal volume of one cubic meter or more. [Ref. 2: 597]

Another definition of containerization which also embodies the idea of efficiency is "...the placing of shipments in various forms of boxes, containers and the like, for the

ease of handling between origin and final destination." [Ref. 1: 46-47]

Still another definition places emphasis on the container as a common denominator in transportation. It must be interchangeable much as the uniform coupling pin and standard gauge of rail track for all railroad cars.

Although definitions differ, the connotation of containerization in carrier and shipper parlance involves the concept of placing goods in a relatively large "box" common to all modes of transportation (except pipeline) to allow the goods to move via any mode or between the modes with a minimum actual handling of the goods themselves.

B. THE INLAND AND MARITIME ORIGINS OF CONTAINERIZATION

As early as the 1800's, large companies used containers to protect cargo from the elements of weather and in 1847 the container appeared in the form of "piggyback" operations; that is, some railroads provided tariffs and services under which farm wagons loaded with produce could be transported without transfer of lading. This was a form of both containerization and "...of piggyback--especially when the farm wagons contained pigs." [Ref. 1: 47]

It could be argued that this was "piggybacking" and not containerization. However, strictly interpreted, "piggybacking" and "fishybacking" today are forms of container service, with the variation that the container is capable of

being moved along the highway as well as being rolled on or off ships or flatcars. The development of this early service was scattered and sporadic, and was eventually discontinued.

Prior to the advent of long distance motor carrier service, the household goods movers' industry used containers for shipment of household goods by rail. A sizable fleet of steel containers, measuring eight feet high, eight feet wide and fourteen feet long, was developed, and household goods were shipped via rail to all points in the United States. The household movers, however, experienced difficulty in the retrieval of containers and in obtaining prompt transportation for containers from points of origin. After the development of the motor carrier, this container use was exchanged for the more flexible service of the trucking industry.

During the 1920's and 1930's container service was offered by the New York Central and Pennsylvania railroads, but the rate structure and other problems eventually discouraged its growth. It was not until the 1950's that the present widespread use of containers by the railways began to materialize.

The introduction of containers to the maritime shipping industry was a logical extension of their earlier use in overland freight transportation. In 1956, Sea-Land, which had its origins in road haulage, started its containership service between New York and Puerto Rico after experimental shipments the previous year between New York and Houston.

Soon after, Matson started its U.S. West Coast-Hawaii container service. But for almost a decade, other shipping lines ignored or rejected the potentialities of containerization, even though by 1966 Sea-Land had nineteen containerships and Matson fourteen [Ref. 3: 12]. The turning point appears to have been 1965, when Sea-Land announced its intention to enter the transatlantic trade routes with containerships. The reaction of established lines on that route was immediate. Each competitor announced its intention to modernize existing vessels and build specialized containerships. Ports on the U.S. East Coast and in Europe soon followed with their plans for container berths. Similar developments occurred in the Pacific trade routes when the Japanese government announced in 1966 a massive containership and berth development program.

Another major force behind the eventual boom in maritime container transport was the U.S. military. At about the same time as Sea-Land entered the North Atlantic trade routes, the U.S. Army became actively interested in containerization. It had long operated its Container Express (CONEX) unit load system, but the Vietnam war build-up provided added encouragement to improve supply methods. At the beginning of 1966, seven hundred containers a month left West Coast ports for South-East Asia; by the end of the year the monthly rate had risen to 1,500 [Ref. 3: 14]. This provided a considerable stimulus to the shipping lines.

However, the most important stimulus to both the inland and maritime use of containers was standardization of the container and its corner lifting devices. A world-wide system of door-to-door transportation could now be established to handle containers of given dimensions. Containerships, cranes, trailers, railway cars, and inland and maritime terminals could be constructed based on these given dimensions.

C. CONTAINER STANDARDIZATION

Without international agreement on basic dimensions and key specifications, containerization would have been severely limited by technical barriers and would not have achieved its present acceptance by the various modes. Created by a 1967 international agreement signed in Moscow, the International Organization for Standardization (ISO), through its 150 technical committees, endeavors to provide standardization guide lines for such diverse fields as plastic chemicals, machine tools and nuclear energy.

The work of international standardization in the field of freight containers is carried out by Technical Committee 104 of ISO. The committee is composed of thirty-one active member countries, and is continually advised by such member representatives as the American National Standards Institute of the United States and numerous qualified international organizations [Ref. 4: 21]. ISO standards issued by Committee 104 are published documentation which serve to clarify

and coordinate such aspects of the container industry as definitions and technical data.

In the area of containerization, ten ISO standards have been published covering dimensions; ratings or weight; specifications for construction, use and maintenance; testing of various types of containers and their associated handling gear; and physical markings. Because it sets forth the standards for dimensions and ratings of freight containers, ISO Standard 688-1973 is of particular interest. This publication establishes three general classifications or series of containers with various container designations included in each and with specific maximum weight ratings assigned to each designation. Series One includes containers from five to forty feet in length and contains seven designation groups. Series Two and Three, composed of three container designations each, are generally shorter in length and weigh considerably less than their Series One counterparts.

Each of the thirteen container designations is assigned a height, width and length with associated tolerances, and a rating defined as the maximum permissible combined weight of the freight container and its contents [Ref. 2: 597]. Although other container sizes exist, ISO Standard 688-1973 can be used to model the standard container in general as an eight foot by eight foot end section with lengths of ten, twenty, thirty and forty feet with ratings of 22,400, 44,800, 56,000 and 67,200 pounds respectively.

D. TYPES OF CONTAINERS AND THEIR USES

ISO Standard R830-1968 addresses the general purpose freight container as well as characteristics of freight containers. Specifically, this standard defines the general purpose freight container as a "freight container of rectangular shape, weatherproof, for transporting and storing a number of unit loads, packages or bulk material; that confines and protects the contents from loss or damage; that can be separated from the means of transport, handled as a unit load and transshipped without rehandling the contents" [Ref. 2: 600]. General purpose containers are normally constructed of steel, aluminum, or fiberglass reinforced plastic laminated plywood and are designed on three broad principles: durability, stackability and versatility [Ref. 5: 94].

ISO Standard R830-1968 further characterizes containers as collapsible or non-collapsible. Although both are of rigid construction, the major components of the collapsible freight container are not permanently assembled and can be folded or disassembled to facilitate storage and back-haul of empty containers. ISO Standard 1946 also classifies general cargo containers into five structural types: (1) closed, including opening roof, (2) open top, (3) open side, (4) open top/open sides, and (5) open top/open sides/open ends.

A variety of containers are in existence in addition to the general cargo container. Many of these have been specifically designed to accommodate the movement of special

commodities or unusual cargos. The following specific types of containers are in common use:

Open-top containers: This design facilitates the overhead loading of cargo such as machinery, sheet glass and long objects that may be unsuitable for end loading apparatus.

Refrigerated containers: "REEFER" containers are constructed of air-tight and heat-shielding materials. A built in or hookup refrigeration unit provides a low temperature for spoilable shipments such as chemicals, drugs or perishable foodstuffs. The temperature is normally adjustable to allow various refrigeration or freezer uses.

Controlled temperature containers: These containers are heavily insulated to limit the range of temperature loss or gain and are most commonly used to transport delicate, electronic instruments.

Heated containers: Heated containers, which require either self-contained heaters or hookup facilities, are utilized in cold climates to prevent damage to cargo from freezing, cracking and brittleness. These containers are commonly used to transport cosmetics through colder regions of the United States and Canada.

Ventilated containers: This type of container ensures a constant air flow around such cargos as perishable foods and hides and skins which can not withstand excess moisture.

Tank containers: Within a structure which conforms to standardized container dimensions, a tank may be fitted to

allow the movement of liquid cargos such as fuel, alcoholic beverages or chemicals.

Shallow tank containers: This is a special form of the tank container that is normally less than eight feet high to permit the transport of high density liquids. This configuration allows the weight of the full container to remain within the capacity of most container handling cranes.

Gondola containers: The main features of an adjustable wooden floor and of telescoping corner posts make this container ideal for loading of various quantities of variable sized material. Bulk materials which are conventionally packed in drums, boxes or crates are frequently shipped in gondola containers.

Automobile containers: Although the use of these containers is obvious when configured to carry automobiles, they may also be easily modified to transport long lengths of lumber, pipe, metal bar stock or finished iron and steel material.

Livestock carriers: The livestock container is equipped with windows, feed boxes and footlocks to prevent the animal from slipping during movement. Although typically used for shipping cattle and horses, these containers can be configured to carry nearly any type of live animal.

The containers described are the most commonly used among the various modes; however, the types of containers available are limited only by the manufacturing decisions of

the sixty-seven companies in the container manufacturing industry. Available containers, therefore, can range from the comprehensive line offered by such giants as Fruehauf of the United States and several Japanese firms to single option or specifically designed units available from several European firms [Ref. 4: 18].

E. MAJOR CONTAINER HANDLING EQUIPMENT

Although a multitude of equipment has contributed to the container revolution, only a broad view of major container handling equipment is presented here. The purpose of omitting such items as specialized forklifts, hoists, trailers, skids, and lashing and securing equipment is not to detract from their value in container movement, but to highlight the pieces of equipment that have played a major role in realizing the potentialities of containerization.

The maritime pioneers, Sea-Land and Matson, proved the utility and significance of cranes used in conjunction with container loading and unloading of ships. Clearly, without this vital equipment, the containerization concept could not have been realized within the maritime industry. Cranes commonly utilized by maritime industry include:

Shipboard mounted gantry cranes: Because the ship is not dependent upon port loading and unloading equipment, these cranes can assume significant value. They operate along tracks installed at the outer edges of the ship's

hatches and are able to easily position their lifting mechanism over the container to be moved.

Dockside container gantry cranes: These rail-mounted cranes can be used to handle all types of cargo, but are specifically designed to move containers weighing as much as thirty tons.

Goliath gantry cranes: These track-mounted cranes are capable of moving extremely large loads. Although not specifically designed to move containers, they are fully capable of performing this task.

Freepath gantry cranes: These immense cranes are highly mobile and able to maneuver on individually steerable wheels to ships inaccesible to a track constrained crane.

General purpose harbor and mobile cranes: These cranes are normally configured as boom cranes rather than gantries and are capable of efficiently performing such diverse tasks as ship-side evolutions as well as truck and railway car loading or unloading.

Instrumental container handling equipment includes not only these giant cranes, but also other specialized, intermodal lifting and moving devices. Straddle carriers, spreaders and container lifters all perform specialized container movement functions based on the requirements of the mode and the containers being moved. [Ref. 4: 52]

A straddle carrier is designed higher, wider and usually longer than the load it is to transport. This carrier is

driven over a container and vertically lifts it for moving or for stacking up to three units high. These carriers are very flexible in all modal operations; however, the use of these straddle carriers in conjunction with gantry cranes in a maritime terminal system offers the maximum of efficiency in container movement [Ref. 6: 31].

Other types of container lifters grasp a container from the side on the top and bottom frames to move it, while yet others apply pressure to the opposite side or end frames to perform the lift. Additionally, scissor lifts and tail lifts on trailers, railway flat cars and platforms both contribute to container movement.

Used with either cranes or forklifts, spreaders are designed to keep a container level during its movement to ensure that the containerized cargo is not damaged. When utilized with cranes to load specially constructed cellular containerships, these spreaders are of further importance because they prevent damage to the container cell loading guides.

The whole concept of containerization is based on the advantages to be gained from a through transportation system, but without the development and refinement of major container handling equipment, these advantages would yet to be realized.

F. THE ADVANTAGES OF CONTAINERIZATION

The ideal situation in the movement of goods from origin to destination is to use equipment constructed to be handled by all links in the transport chain. It is in the provision of such equipment that the container comes into its own. The shipper is able to load the container on his own premises, have it hauled by road or rail to a suitable port where it is loaded on a containership, transported to the foreign port, unloaded to an internal transport system, and delivered to his customer without each individual package of the consignment being handled at each intermediate stage. It is this "through" concept of containerization which considerably reduces the need for manpower, changes the system into a capital intensive one, and thus allows savings to be made. Conventional methods involve the use of several smaller operators, each of which could well delay the consignment on its journey. For example, a typical shipment could conceivably pass through the hands of the original vendor, a forwarding agent, a packaging firm, a road hauler and/or the railway system, the port authority, dock workers, custom officials, ships' stevedores, the shipping company, and a similar chain on arrival of the transporting vessel in an overseas port, before final delivery to the consignee could be effected. Each operator would assess his own costs and charge accordingly, and each stage would require documentation covering that part of the journey only. Using a fully containerized

system, however, where a through movement is made possible, most of these intermediaries are eliminated, and it is possible to radically revise documentation. Ideally the container should not be opened en route, and, if an effective locking system is used, pilferage can be greatly reduced.

A long transportation pipeline, however, is not a prerequisite to realizing the advantages of containerization. Containers are attractive to shippers simply because of reduced cost. Such savings are the result of reduced handling, reduced damage, reduced pilferage, less packaging, reduced paperwork and lower transportation cost [Ref. 7: 191].

Typically, the rugged construction of a properly loaded container greatly reduces damage and breakage of cargo. The frequency of handling the actual cargo is greatly reduced by containerization, and with reduced commodity handling comes reduced risk of damage. Through containerization, products arrive in better condition enabling companies to pursue significant advantages in marketing and distribution.

Containers also reduce pilferage, a common occurrence with shipments of whiskey and other high value products, and at times referred to as "...an undeclared fringe benefit of longshoremen" [Ref. 1: 51]. The use of containers has, to a large extent, eliminated this fringe benefit, and produced large savings. For example, it has been estimated that twenty per cent of all whiskey shipped conventionally through

New York was disappearing before containers were utilized [Ref. 6: 40].

Perhaps the greatest costs in transportation for a shipper are his packing and packaging charges. Prior to containerization, all export shipments had to be specially packed, utilizing wood or certain types of damp-resistant paper to offset shipboard climatic conditions. Containers have cut packaging costs considerably. Export shipments in containers require no more packaging than domestic shipments thus achieving significant savings. The dollars saved could very well give the merchant a competitive edge in his selling price or allow him to enter markets previously beyond his economic reach.

A counter argument is that crating and packaging costs are replaced by costs of the additional weight and volume of the container. In most cases, however, these costs are transparent to the user: containers are supplied to the shipper by the carrier, and similarly to other carrier-owned transportation equipment, escape freight charges. Rates are based on weight of contents or volume of container.

In addition to dollar savings, containerized cargo has the potential to reduce paperwork. Although containers are still hampered by the "paper barrier," a container could conceivably be shipped from consignor to consignee on only a single bill of lading. Currently a container outbound from the United States requires forty-six documents, while an

inbound container requires seventy-eight [Ref. 1: 51]. However, due primarily to the efforts of the National Committee on International Trade Documentation, an international coordinator for trade paperwork, the voluminous documentation is being streamlined [Ref. 8: 73]. The Committee's most significant achievement has been the international acceptance of the simplified Standard Master form of documentation. Although this standard form does not directly replace all documentation, it allows, through the use of chemically-treated paper, the simultaneous completion of the most commonly used shipping documents.

Containerization changes the material handling function from a labor intensive to a capital intensive operation. Less labor is required to handle containerized freight because the container, by definition alone, is too large and too heavy to be manually moved. Especially in periods of continual inflationary labor costs, many firms have found containerization to be a desirable avenue for increasing productivity and controlling material handling costs. Labor savings as well as greater time efficiency in the transfer of containers among modes is well illustrated by the conclusions of the National Port Council for berth productivity for different handling systems:

Containers: Thirty tons can be loaded and unloaded per man hour.

Pallets: 4.5 tons can be loaded and unloaded per man hour.

Conventional: 1.7 tons can be loaded and unloaded per man hour.

Hence, containerization can achieve an eighteenfold and sevenfold increase in productivity when compared to the conventional and pallet handling systems respectively. [Ref. 3: 79]

Clearly, there is no doubt that containerization presents advantages. Containerization has pronouncedly achieved its objectives of reduced transportation costs and better and more reliable customer service [Ref. 9: 33].

III. CONTAINERIZATION IN THE MILITARY

Since the first use of containers on a sizeable scale in the 1950's, the military has recognized the importance and benefits of containerizaton in its world-wide logistics effort. Because of the inherent advantages of containerized cargo movement including the ability to move large quantities of material effectively and rapidly, the military has long been an advocate of containerization.

A. DEVELOPMENT OF MILITARY-OWNED STANDARD CONTAINERS

After World War II a review was made of the Army's basic logistic system. From this review, it became readily apparent that a method of consolidation of shipments and reduced handling was needed. The first container experimented with in 1948 was constructed of wood and was utilized to ship household goods to and from overseas. Metal containers were first used in 1952 to move cargo from Columbus General Depot in Ohio to Yokohama, Japan, and eventually into Korea. In 1956, the Departments of the Army and Air Force agreed to the world-wide joint operation of a Container Express (CONEX) service to provide a global system for the consolidation and rapid movement of critical cargos for troop supply support.

In the 1960's, the Army's accumulated inventory of approximately 225,000 CONEXs represented the world's largest

container fleet. Although the Army is no longer purchasing non-ISO standard CONEXs, they were initially constructed of steel in two sizes (6'3" x 6'10.5" x 4'3" and x 8'6") capable of being intermixed for shipping, tiering, or storing. The type I CONEX, designed for high density cargo, is one-half the size of the type II but has the same weight capacity of 9,000 pounds as the larger type II. The type II container is the most popular size and was considered the backbone of support during the Vietnam conflict.

In May 1967, Colonel R. E. Wheelis, Director of Transportation at the United States Army Material Command, stated that the military container must be light in weight, able to fit in standard container wells, and compatible with fast deployment logistic ships, C-5 and C-141 aircraft, roll on/roll off (RO/RO) vessels, military cargo helicopters, military transport vehicles, material handling equipment and ISO standards [Ref. 10: 7]. Such a system was implemented in May 1968 with the initial procurement of 2,000 containers and 1,750 chassis. An additional 4,700 containers and 2,635 chassis were approved by the Department of Defense (DOD) with Fiscal Year 1969 funds. The complete procurement package consisted of a container, a coupleable chassis, and a movable bogey. The chassis and bogey are generally used as one unit defined as a semi-trailer with framework (chassis) supporting the container for over-the-road movement and equipped with running gear (bogey) and front end support (landing gear).

These 6,700 military vans (MILVANS) are today's military-owned intermodal fleet of 8x8x20-feet cargo containers comparable to commercial containers that follow ISO standards.

Of the MILVANS procured, 4,500 had built-in restraint systems to permit transport of ammunition. Although efforts have been made to secure accreditation by the U.S. Coast Guard and American Association of Railroads of restraint systems to permit carriage of ammunition in commercial containers, these 4,500 restraint MILVANS are currently the only ones approved for ammunition transport. These restraint MILVANS as well as the remaining 2,200 non-restraint MILVANS are dispersed throughout the continental United States and overseas DOD organizations and installations.

B. CONTAINERIZED CARGO MOVEMENT WITHIN THE MILITARY

To appreciate the movement of containerized cargo in the military, a basic understanding of the military transportation system is required. Historically, military transportation responsibilities have been organized along modal lines with DOD maintaining and operating sufficient peacetime, government-owned transportation resources in each of the modes to meet contingency requirements which are unable to be met by commercial sources.

These resources constitute the Defense Transportation System (DTS) which is operated along service lines, with the Army, Air Force, and Navy assigned specific transportation

responsibilities. The Army executes its responsibilities for ocean terminal service and land transportation through the Military Traffic Management Command (MTMC). The Air Force meets its air transportation responsibilities through the Military Airlift Command (MAC). The Navy performs its responsibilities for ocean transportation through the Military Sealift Command (MSC).

Each of these transportation agencies acts as the single manager for the particular mode of transportation provided and either purchases transportation services from commercial carriers or arranges shipment via DOD organic transportation assets. These individual agencies report via their own particular military service chain of command to their respective service secretary who is in turn responsible to the Secretary of Defense. The Secretary of Defense, as the overall manager of the DTS, disseminates major transportation policy and direction to MTMC, MAC, and MSC.

Each transportation agency, as the single manager for its respective transportation responsibilities, is accountable for executing these DOD policies. As such, these agencies hold the key to the success of the entire DTS operation generally and, specifically, the effectiveness and efficiency of containerized cargo movement in the military.

C. MSC AND CONTAINERIZED CARGO MOVEMENT

An integral part of the DTS is the Military Sealift Command whose primary mission is to provide sealift capability for not only the Navy but also the entire DOD and other authorized government agencies. As part of the operating forces of the Navy, MSC is responsible through its Commander (COMSC) to the Chief of Naval Operations (CNO). COMSC is the executive agent of the Secretary of the Navy, who, in turn, is the single manager for all DOD sealift requirements. As such, COMSC is responsible for carrying out the mission of MSC.

As the military's sealift manager, COMSC is organized world-wide and, hence, is ideally suited to take best advantage of containerization. Under the direction and authorization of COMSC, each of the four MSC Commanders is responsible for sealift capability in their respective areas of Europe, Atlantic, Pacific, and Far East. Besides a headquarters office in each of these areas, additional ancillary offices are widely dispersed within each area to ensure effective MSC sealift operations world-wide.

Specific responsibility for the maintenance and advancement of intermodal sealift capabilities rests with the Cargo Division of COMSC. The Director of the Cargo Division is responsible for exercising management control over the operational functions of moving DOD cargo via intermodal transportation systems in MSC-controlled ships, recommending and

taking appropriate action to improve container utilization, and determining and evaluating current and future world-wide availability of commercial containers and other intermodal transportation services. [Ref. 11: 3T-5-3T-6]

D. DEPARTMENT OF DEFENSE POLICY ON CONTAINER SEALIFT

Because containerization has become the dominant method of carriage in ocean transportation, DOD has recognized that military requirements for both peacetime and contingency operations will have to be met through a changing mix of increasingly containerized and decreasingly break-bulk sealift capabilities. Consequently, it is the intent of DOD to capitalize fully upon the inherent advantages of containerization and, within the constraints of resource availability, containerize all ocean-going military cargo that is susceptible to containerization while remaining consistent with operational circumstances [Ref. 12: 2].

In accomplishing this goal, it is also DOD policy to rely primarily on the use of commercial container resources insofar as these resources are responsive to military requirements. For those remaining requirements that cannot be met by commercial sources, DOD-owned or long-term leased container services under the direction of MSC are authorized as a means of satisfying military requirements. As a result of this policy, it is incumbent on MSC, as the sole military operating agency responsible for the ocean transportation

requirements of its customers, to utilize the advantages of containerization in order to maximize military sealift capability.

IV. PROBLEM EVOLUTION

Since January 1978, MSC has been utilizing Army-owned MILVANS on loan to the Navy to meet the sealift requirements of Commander, Naval Supply Systems Command (COMNAVSUPSYSCOM) for dry cargo container service on four Pacific logistics pipelines. In January 1982, the Army initiated a recall of all MILVANS in MSC possession [Ref. 13: 1]. This recall, to be completed by September 1983, has the potential for disrupting dry cargo resupply service on these Pacific logistics pipelines.

A. MILVAN SERVICE DEVELOPMENT AND MILVAN RECALL

In November 1976, COMNAVSUPSYSCOM addressed the requirements of MILVAN service to Naval Station, Midway and Naval Communications Station, Diego Garcia [Ref. 14: 1]. These initial requirements have eventually evolved into MSC currently providing dry cargo container service because of the lack of through commercial container service for the following pipelines:

1. Between Oakland and Midway, Wake, and Diego Garcia;
2. Between Port Hueneme and Diego Garcia and Antarctica;
3. Between Pearl Harbor and Midway, Wake, and Subic Bay; and
4. Between Subic Bay and Diego Garcia.

To meet these requirements, COMSC established four pools of 8x8x20 feet dry cargo containers in Oakland, Port Hueneme, Pearl Harbor, and Subic Bay. These four pools are supported by container assets obtained through a Memorandum of Agreement (MOA) between the U.S. Army Material Development and Readiness Command (DARCOM) and MSC [Ref. 15: 1-3]. This MOA, signed in November 1977, is the basis for providing MSC with the serviceable MILVANS and MILVAN chassis with bogies to meet current COMNAVSUPSYSCOM containerized dry cargo sealift requirements.

As of January 1982, container assets to meet these requirements consisted of 645 restraint and 20 non-restraint MILVANS on loan to MSC by DARCOM [Ref. 16]. However, in accordance with the MOA provisions, DARCOM's letter of 26 January 1982 announced the recall of all restraint MILVANS to support the Army-sponsored Containerized Ammunition Distribution System (CADS) and ammunition related contingency requirements. Because the twenty non-restraint MILVANS can be converted to use in the CADS, these are also being subjected to recall by September 1983 [Ref. 16].

B. CONTAINER SERVICE REQUIREMENTS

Precipitated by the pending loss of its MILVAN assets to support the four established container pools, COMSC requested COMNAVSUPSYSCOM to reconfirm its requirement for MSC-provided container service [Ref. 17: 1]. Concurrently, COMSC

requested the Pacific and Far East Area Commanders having cognizance over these container pools to provide dry container requirements under the assumption that the MSC-provided container service to COMNAVSUPSYSCOM was to be continued at the existing level [Ref. 18: 1]. COMNAVSUPSYSCOM has validated the required logistics support to continue the current readiness posture [Ref. 19: 1 and Ref. 20: 2]. Based on its evaluation of the Area Commanders' responses [Ref. 21: 1 and Ref. 22: 1], COMSC has identified the long term requirement for acquiring 680, twenty-foot dry cargo containers to replace lost MILVAN assets and to be positioned as follows: Oakland, 80 containers; Port Hueneme, 125 containers; Pearl Harbor, 125 containers; and Subic Bay, 350 containers.

C. STATEMENT OF THE PROBLEM

DARCOM's recall of the MILVAN assets used by MSC to support COMNAVSUPSYSCOM's four Pacific logistics pipelines has created the need to obtain 680 twenty-foot dry cargo containers equivalent to the current MILVAN specifications considering today's ISO container standards. The central issue that requires resolution is determining the most cost-effective method to acquire the required containers.

V. AN OVERVIEW OF COMMERCIAL OCEAN CONTAINER ACQUISITION

This chapter describes from the perspective of the potential purchaser the market for new ocean containers. In a general way, it answers the questions of where should one buy them, what is the price, and what are the considerations involved in financing an acquisition through a long term lease.

The term "leasing companies" is used in the following sections. Leasing companies are businesses that acquire containers either through purchase or long term lease and then, in turn, lease them on a short term basis to shipping companies. While a true long term lease is ten to fifteen years, leasing companies generally do not provide leases for more than a five year period. However, leasing companies will occasionally act as brokers of long term leases.

A. GEOGRAPHY OF SUPPLY

The major sources of standard steel ocean containers are Korean and Japanese manufacturers who share about equally seventy-five to eighty percent of the market. Taiwanese suppliers provide a significant portion of the remaining market share. China, Italy, Germany, France, South Africa, and the United Kingdom manufacture relatively small amounts. Virtually no containers are manufactured in the United States.

There are two reasons for the Japanese and Korean dominance. The obvious reason is efficiency. Japan combines the world's most efficient container production lines with steel from the world's most efficient mills. Korean producers are only a small step behind Japanese in labor efficiency while offering lower wages than in Japan. The situation of Taiwan is similar to that of Korea. Both Taiwan and Korea draw on Japan for steel supplies.

The second reason for market dominance is not obvious. It stems from the nature of the container shipping business. From the perspective of the shipping line, a new container is not useful until it is positioned in a location where the line has freight. Thus the appropriate measure of container procurement expense to a commercial shipping firm includes the insurance and freight to a high demand port. On a trans-oceanic container positioning move, these costs are in the range of four hundred to seven hundred dollars per container. Thus the container market responds to average patterns of supply and demand, and positioning expenses are minimized if container manufacturers are located where there is--on the average--the greatest demand for the shipment of goods in containers. For the past decade the greatest demand for space has been in Japan, Korea, Taiwan, and Hong Kong.

In summary, a purchaser generally buys containers from North Asian manufacturers because they are high quality containers and, once having been purchased, can be loaded

directly without paying a positioning charge in addition to the purchase price.

B. PRICES AND TERMS EX FACTORY

In discussing container prices ex factory, it is sufficient to limit the consideration to twenty-foot containers. This is because the price for forty-foot containers is a stable multiple of the twenty-foot container price. Both the factories and their customers use a factor of 1.65 to relate the price of forty-foot containers to the price of twenty-foot containers. For example, if a manufacturer will deliver a twenty-foot container for $2100, then its price for a forty-foot container will be $2100 x 1.65 = $3465.

The terms of a particular production run are set in advance by a contract which specifies the physical characteristics in detail and defines precisely the financial arrangements. The container prices in these contracts are determined by two sets of factors: one internal to the acquisition and the other external to the acquisition.

1. Features Internal to a Contract Which Influence Price

a. Design Details

Containers differ significantly in design and construction specifications. The biggest difference is in material: aluminum, corten steel (atmospheric corrosion-resistant steel), or mild steel (noncorrosion-resistant steel). Each material choice introduces more subtle choices

of section shapes, reinforcement schemes, and painting systems.

Each manufacturer will have a standard design for each of the three materials, but most larger customers specify their own details with the understanding that the greater the divergence from factory standard, the greater the price.

There are general indicators of magnitudes. Aluminum is about twice the cost of mild steel. Corten steel is about ten per cent more expensive than mild steel. The most idiosyncratic design details are ten to fifteen per cent more expensive than the standard design details.

b. Financial Details

The prices for containers will vary with the payment terms. Almost always there is a discount available for cash payment at delivery. But more conventionally the manufacturers provide 90 to 180 days credit, in which case they add on not only contractual interest but also a little extra to cover foreign exchange risk and customer risk.

2. <u>Features External to a Contract Which Influence Price</u>

a. Capacity Utilization

The Asian manufacturers display corporate behavior unusual in the United States: when demand goes down they lower prices and, if demand goes way down, they lower prices significantly. Conversely, they ration their production during periods of high demand by increasing prices rapidly.

The swing from price peak to trough can be as much as twenty-five per cent.

b. Foreign Exchange Rate

The majority of purchase contract prices are in dollars, but the costs are in yen, won, or NT (Taiwanese) dollars. Thus any significant currency realignments will affect container prices. For example, the yen has fallen from 190 yen per $1 to 255 per $1. Dollar purchasers have seen the dollar price of Japanese containers decline as a consequence.

c. Price of Steel and Aluminum

As an approximation, steel inputs account for half the cost of a steel container, and aluminum inputs account for two-thirds to three-fourths of the price of an aluminum container. Thus changes in the market price of these materials will be reflected in proportional changes in the container prices.

The reason for enumerating these major external and internal factors in the pricing of containers is to provide a basis for understanding why one cannot easily say what containers cost. Instead, one can provide a range determined by the external features at any point in time. Today the range for steel twenty-foot containers is $1800 to $2200. A year ago the range was $2100 to $2500. Where a particular acquisition falls within the range is a function of the internal features explained above.

A final variable worth noting is the role of the trading company. Most container purchasers work through a Japanese trading company of which Mitsui, Mitsubishi, and C. Itoh are the most active in this field. The trading companies act as middlemen in the transaction and charge a fee of about one to three per cent of the purchase price. They are critical to the quality control function. Failure to manage quality control has left many purchasers with equipment grossly different than that specified in the contract, and this experience should serve to alert a prospective purchaser in cases where the terms of an acquisition seem unusually attractive.

C. LEASING RATHER THAN BUYING

The contract between the manufacturer and the user of the equipment is largely independent of the way the user chooses to finance the acquisition. The major alternatives are purchasing and acquiring by long term lease. In the lease case, the user or user's agent arranges the contract with the manufacturer. The contract is then assigned to the party who will own the equipment and receive the lease payments.

The lease alternative exists primarily because many container users cannot use the tax benefits accruing to the owner of the equipment. Such users include public entities such as a national shipping company. Hence, the lessor may be a party who has taxable income from other business

ventures and needs tax shelters or credits. Additionally, lessors exist as independent leasing firms.

The terms of long term container leases are determined by the state of the financial markets because the lessor views the transaction as just another form of long term financial investment. Thus, the price or "the lease rate factor" goes up or down with the long term interest rates in the market. Currently, for ten year leases, the lease rate factor is about .15; in other words, the annual lease payment is fifteen per cent of the purchase price of the container. If the long term rates come down to twelve per cent, the lease rate factor would be around .13 to .133 depending on the customer's credit worthiness.

In addition to the variables of long term interest rates and credit worthiness of lessee, the purchase option in the lease agreement can influence lease costs. This type of option is determined by the lessee's requirements and the lessor's legal constraints as reflected in current tax legislation and can be expressed as a factor or percentage of the purchase price.

VI. BASELINE ANALYSIS OF ALTERNATIVE PROBLEM SOLUTIONS

An analysis inquiring into the costs and benefits of a program whose characteristics are assumed to be given can center on two different types of questions. The first is the complete cost-benefit question: whether the value of all benefits exceeds that of all the costs. The evaluation question can also be turned around to ask the second type of question: for several alternative courses of action that accomplish a particular goal or program, which is the least expensive? It is the second type of question that this analysis endeavors to answer by performing a comparative or cost-effectiveness evaluation of alternative problem solutions.

A. OBJECTIVE AND SCOPE OF THE ANALYSIS

The objective of this analysis is to assist decision makers within COMSC in determining the most cost-effective method of acquiring standard containers to replace lost MILVAN assets. Because decision makers at various levels within COMSC have identified the acquisition requirement to be 680 steel, twenty-foot length containers conforming to current ISO and industry standards, this analysis will evaluate alternatives given this specific definition of the requirement.

For purposes of this analysis, a typical twenty-foot steel container conforming to ISO and current industry standards is defined as measuring 8'6"x8'x20' and usually constructed of corrugated sheet steel walls that are welded to the main structural top and bottom side rails and end frames, which are of fabricated or shaped steel sections. The end frames are fitted with corner fittings (steel castings to provide a means of handling, stacking and securing containers) at all eight corners that are usually welded to the four corner posts, top and bottom side and front rails, and rear door sill and header. The roof is normally flat sheet steel welded to the top side and end rails and door header, and has interior roof bows for support. The doors are usually plymetal (steel-faced wood) panels fitted with locking hardware and weatherproof seals. The floor is normally constructed of hard laminated woods, planking or plywood either screwed or bolted to the cross members. Cross members that support the floor are variously configured beams bolted or welded to the bottom side rails. Although exact specifications can vary, this analysis will be based on high quality specifications currently used by such industry leaders as Container Transport International, Incorporated; Transamerica ICS; ITEL Container Division; Genstar Container Corporation; and American President Lines, Limited. Using such specifications without proprietary rights will ensure that the containers ultimately acquired are high quality steel containers that are readily

available from commercial sources. As a cautionary note, it is pointed out that any major deviations from the general specifications given and from specifications in common use by industry leaders can significantly alter the results of this analysis.

B. ALTERNATIVES AND CRITERION FOR RANKING ALTERNATIVES

The alternatives evaluated in this analysis to meet the long term requirement for 680 steel 8'6"x8'x20' containers are:

1. Alternative One: Negotiating a long term lease without an option to buy.
2. Alternative Two: Negotiating a long term lease with an option to buy at the expiration of the lease contract.
3. Alternative Three: Negotiating a purchase of the required containers.

The criterion for the selection and ranking of alternatives is fixed effectiveness with minimum cost to COMSC in providing the required level of container service to COMNAVSUPSYSCOM for support of its four Pacific logistics pipelines. The principle reason for the selection of this criterion is COMNAVSUPSYSCOM's stated objective of maintaining the required logistics support to continue the current readiness posture. [Ref. 19: 1 and Ref. 20: 2]

C. THE COST MODEL

Because all of the alternatives selected for evaluation are capable of supporting COMNAVSUPSYSCOM's current readiness

posture, the focus of the evaluation of alternatives is on minimizing the costs required to achieve and maintain this posture. To identify and accumulate costs, this analysis utilizes a cost model consisting of:

1. Cost Component One (C1): A lease rate factor based on the state of financial markets.

2. Cost Component Two (C2): An option to buy factor based on legal constraints reflected in current tax laws.

3. Cost Component Three (C3): Purchase price as a function of specifications, credit terms, quality control, and negotiating skills.

4. Cost Component Four (C4): Pick-up charge as determined by supply and demand of containers at the desired pick-up point.

5. Cost Component Five (C5): Depot handling charge at the desired pick-up point.

6. Cost Component Six (C6): Drayage (line haul charge) from desired pick-up point to desired military depot at on-hire of containers.

7. Cost Component Seven (C7): Drayage at off-hire of containers from military depot to desired drop-off point.

8. Cost Component Eight (C8): Depot handling charge at drop-off point.

9. Cost Component Nine (C9): Drop-off charge as determined by supply and demand of containers at the desired drop-off point.

10. Salvage Value Component (SV): The residual value of a container that can be realized at the end of its economic life.

Maintenance and repair costs as well as all other costs associated with containerized cargo movement are not addressed because these costs are invariant since containers must be maintained, repaired, and transported by the user regardless whether they are leased or purchased. The total cost equation will be in the general form of:

$$TC = (C1xC3) + C3 + C4 + C5 + C6 + C7 + C8 + C9 + (C2xC3) - SV.$$

However, the cost components will differ among alternatives being considered and will be deleted as appropriate to the alternative.

D. ALTERNATIVE ONE: LONG TERM LEASE WITHOUT THE OPTION TO BUY

1. Alternative One Assumptions

The economic life and long term lease are for a period of ten years. An economic life of ten years is considered appropriate based on the typical economical lives used by industry leaders. A long term lease period of ten years is based on COMNAVSUPSYSCOM's long term commitment to support its four Pacific logistics pipelines.

Delivery and control of leased containers will be made to Military Sealift Command, Pacific (MSCPAC) for further repositioning to container pools, and will occur

instantaneously versus incrementally. MSCPAC is assumed to be the control point because it serves as the Area Commander for three of the four container pools and is the major focal point for the majority of containerized cargo movement. Instantaneous versus incremental delivery to MSCPAC as well as instantaneous redelivery to the lessor at the expiration of the negotiated lease is assumed in order to simplify cost calculations. It is believed, however, that this simplification will not adversely distort cost estimates.

Leased containers will be obtained through major West Coast container leasing companies offering high quality steel containers of new or like-new construction. New or like-new construction is defined as recently manufactured containers used only in a positioning move from factory to desired pick-up location. The assumption to acquire container assets through West Coast container leasing companies is based on a normally inherent desire to reduce pick-up, drop-off, and drayage charges. New or like-new construction is assumed to support a ten year economic life to eliminate or minimize exchange of container assets between the lessor and lessee.

The long term lease rate for a ten year period is assumed to be a function of the financial markets because major container leasing companies view container leasing as another form of long term investment. An annual long term lease rate of fifteen per cent of the purchase price of a steel container meeting specifications of industry leaders is

assumed based on a review of the current, nominal-risk, long term investment opportunities.

The purchase price for a new or like-new steel container used for computing the long term lease basic cost is $2100. This assumed purchase price represents an average of purchase prices formulated in late September 1982 by major container leasing companies and major ocean carriers of containerized cargo.

Pick-up and drop-off charges, and all drayage and handling charges in the San Francisco Bay area are typical of actual charges that will be incurred. This assumption is made to permit the use of specific quotes of these charges obtained from industry leaders located in close proximity of MSCPAC.

All costs are stated in 1982 dollars because they are utilized to support economic analysis purposes versus budgetary purposes.

2. <u>Alternative One Baseline Costs</u>

The pertinent cost components associated with this alternative can be utilized to form the total cost (TC) equation of one container as follows:

$$TC = (C1 \times C3) + C4 + C5 + C6 + C7 + C8 + C9.$$

This equation can be further manipulated to yield the total annual cost of leasing 680 standard steel containers for each year of the ten year lease period.

Using a lease rate factor (C1) of fifteen per cent and a purchase price (C3) of $2100 per container, the annual basic cost of leasing 680 containers is $214,200.

Based on representative quotes from major container leasing firms and shippers, the pick-up charge (C4) of $35 per container is utilized for cost estimating. Hence, in year one of the lease period, the total pick-up costs are $23,800.

The depot handling charge at the desired pick-up point (C5) is also based on typical costs cited by industry leaders. Using a charge of $25 per container produces total handling charges of $17,000 in year one.

The drayage charge at on-hire (C6) of $30 per container was similarly ascertained and yields total drayage costs in year one of $20,400.

The foregoing costs are required to achieve and maintain a level of container service to sustain COMNAVSUPSYSCOM's current readiness posture. The costs addressed below are those that will be incurred at lease expiration at the end of year ten and are mirror images of the accessorial charges of cost components C4, C5, and C6.

Drayage at off-hire (C7) of $30 per container will add $20,400 to year ten costs while the depot handling charge at the desired drop-off point (C8) of $25 per container will increase costs in year ten by $17,000. Finally, using an assumed typical drop-off charge at the lessor's depot (C9) of

$35 per container will cause the total cost to rise by another $23,800.

The annual cost of leasing 680 standard steel containers for each year of the ten year lease period is summarized in Table I. Table I displays both undiscounted and discounted annual and total baseline costs of alternative one. The discounted costs, included to show the opportunity cost of capital, are based on a ten per cent discount rate established by DOD as the rate to be used in all economic analyses of proposed Defense investments. The present value of the baseline costs to implement alternative one is $1,464,118.

TABLE I

ALTERNATIVE ONE BASELINE COST SUMMARY

Year	Annual Cost	Discounted Annual Cost
1	$275,400	$262,732
2	$214,200	$185,711
3	$214,200	$168,790
4	$214,200	$153,581
5	$214,200	$139,658
6	$214,200	$126,806
7	$214,200	$115,240
8	$214,200	$104,744
9	$214,200	$ 95,319
10	$275,400	$111,537
Total	$2,264,400	$1,464,118

E. ALTERNATIVE TWO: LONG TERM LEASE WITH THE OPTION TO BUY

The option to buy feature in a long term lease can be treated in two fundamental ways. The option to buy cost can be based on a fair market value to be determined at the expiration of the lease or can be based on a fixed price determined during initial lease negotiations. The fixed price method of "buy-out" can take two further forms. It can consist of increased basic leasing costs combined with a nominal purchase price of, for example, one dollar per container. The fixed price method can also take the form of a more substantial fixed purchase price at lease expiration without an increase in basic leasing costs. Both fundamental methods of incorporating an option to buy feature into a leasing arrangement have the same effect: compensating the lessor for his initial investment.

When incorporating an option to buy feature in a leasing arrangement, the corporate lessor must view it using federal income tax laws as a backdrop. These tax laws aid in characterizing lease transactions as leases for corporate federal income tax purposes. Hence, the corporate lessor must ensure his contractual leasing arrangement is indeed a lease as defined by the federal income tax laws if he is to advantageously use these laws to achieve reduced corporate tax liability. A major factor in determining whether a lease has been negotiated for federal income tax purposes is the treatment of the fixed price option to buy. Prior to the Tax

Equity and Fiscal Responsibility Act of 1982, the Internal Revenue Service considered the fixed price purchase option as evidence that a corporate lease transaction was not a lease for federal income tax purposes [Ref. 23: 22]. However, once this legislation is in effect, a fixed price option of at least ten per cent of the original property or equipment purchase price will no longer disqualify a corporate lease transaction as a lease for federal income tax purposes [Ref. 23: 65].

The enactment of this legislation will provide corporate lessors with a minimum option to buy factor that must be met to qualify for tax advantages under a leasing arrangement. Assuming profit to be the prime motivator in corporate behavior, corporate lessors will meet this minimum option to buy factor to maximize profit through advantageous use of tax laws. Hence, the ten per cent minimum option to buy factor of this 1982 tax legislation will be used to predict corporate behavior in determining the cost of an option to buy feature incorporated in a long term lease.

1. Alternative Two Assumptions

Assumptions of alternative two include those previously stated in alternative one; however, additional assumptions are made about the option to buy feature and salvage value of owned containers acquired through the exercise of the option to buy.

When evaluating alternatives, it is highly desirable to compare them using equal periods of time in which expenditures occur and benefits accrue. Thus, to facilitate comparison of all alternatives, a ten year lease period is also used in evaluating alternative two. The choice of this ten year lease period further permits the continued use of a fifteen per cent lease rate factor versus a higher factor precipitated by a shorter term lease, and allows the introduction of an option to buy factor based on current tax legislation. Therefore, it is assumed that the option to buy will be exercised at the end of the last year of the ten year lease period. The cost for exercising this option is represented by an option to buy factor of ten per cent of the purchase price of a standard steel container. The option to buy factor is based on the Tax Equity and Fiscal Responsibility Act of 1982 requirements and assumes that COMSC will be able to negotiate the best possible terms for an option to buy feature.

This alternative also assumes a salvage value of $300 per container obtained through exercising the option to buy that can be used to offset other year ten costs. The $300 salvage value arises primarily because of the value of the steel used in construction of the container and is based on estimates obtained from major container leasing firms and ocean carriers of containerized cargo. Furthermore, it is assumed that this salvage value can be realized at any one

of the four container pools without the necessity of COMSC repositioning its containers.

2. Alternative Two Baseline Costs

Because this alternative assumes a buy-out at the end of the lease period and at the end of the economic life of a container, the focus of this alternative is clearly on trading off buy-out costs and salvage value against the other year ten costs detailed in alternative one.

By exercising the option to buy, the total cost equation of one container becomes:

$$TC = (C1xC3) + C4 + C5 + C6 + (C2xC3) - SV.$$

This equation can be further manipulated to yield the total annual cost of leasing with a fixed price option to buy 680 standard steel containers for each year of the ten year lease period. However, only the costs incurred in year ten will differ from alternative one.

Using an option to buy factor (C2) of ten per cent and a purchase price (C3) of $2100 per container, the cost of exercising the option to buy 680 containers at the end of year ten is $142,800.

A salvage value (SV) of $300 per container yields a total residual value of $204,000 that will be realized in year ten.

The drayage (C7), handling (C8), and drop-off (C9) charges at off-hire in year ten are avoided under this alternative.

Table II displays the undiscounted and discounted differential costs between alternatives one and two. A ten per cent discount rate was used to obtain the present value cost to implement alternative two of $1,414,546.

TABLE II

DIFFERENTIAL COST SUMMARY BETWEEN ALTERNATIVES ONE AND TWO

Cost Item	Undiscounted Cost	Discounted Cost
Alternative One Costs	$2,264,400	$1,464,118
Buy-out Cost	$142,800	$57,834
Salvage Value	($204,000)	($82,620)
Drayage Cost	($20,400)	($8,262)
Handling Cost	($17,000)	($6,885)
Drop-off Cost	($23,800)	($9,639)
Alternative Two Costs	$2,142,000	$1,414,546

F. ALTERNATIVE THREE: NEGOTIATING A PURCHASE

1. Alternative Three Assumptions

The previously stated assumptions of a new or like-new container, a ten year economic life, instantaneous delivery and control of containers to MSCPAC, and a $300 salvage value per container from alternatives one and two are applied to alternative three. The accessorial charges of pick-up, handling, and drayage at on-hire of leased containers are also assumed to be incurred at the time of container purchase because purchased containers must be properly positioned prior to use in the Defense Transportation System (DTS).

The purchase price of a new or like-new container will be primarily a function of specifications, credit terms, quality control, and negotiating skills. A purchase price of \$2100 F.O.B. West Coast is assumed and presupposes using high quality specifications similar to those in use by major container leasing companies; using credit terms of cash payment within 180 days; using DOD personnel to perform the quality control function; and presupposes that COMSC's negotiating skills will achieve the best possible purchase price in today's market.

2. Alternative Three Baseline Costs

The appropriate cost components of the cost model can be combined to form the total cost equation of purchasing one container as follows:

$$TC = C3 + C4 + C5 + C6 - SV.$$

This equation can be further manipulated to yield the total cost of purchasing 680 standard steel containers.

Using a purchase price (C3) of \$2100 per container, the total purchase price of 680 containers is \$1,428,000.

Pick-up (C4), handling (C5), and drayage (C6) charges at time of purchase and salvage value (SV) realized in year ten are the same as calculated in alternatives one and two and are displayed in Table III.

Table III displays both the undiscounted and discounted total costs of alternative three. A ten per cent

TABLE III

ALTERNATIVE THREE BASELINE COST SUMMARY

Cost Item	Undiscounted Cost	Discounted Cost
Purchase Price	$1,428,000	$1,362,312
Pick-up Cost	$23,800	$22,705
Handling Cost	$17,000	$16,218
Drayage Cost	$20,400	$19,462
Salvage Value	($204,000)	($82,620)
Total	$1,285,200	$1,338,077

discount factor was used to obtain the total present value cost to implement alternative three of $1,338,077.

G. BASELINE ANALYSES SUMMARY

Table IV displays the undiscounted and discounted total costs of the alternatives evaluated. Using the criterion of fixed effectiveness with minimum cost to COMSC, alternative three is the preferred option; however, alternative three is superior only under the assumptions explicitly stated in the baseline analyses. The following chapter examines the strength of alternative three's superiority under varying assumptions.

TABLE IV

SUMMARY OF ALTERNATIVE BASELINE COSTS

Alternative	Undiscounted Cost	Discounted Cost
1	$2,264,400	$1,464,118
2	$2,142,000	$1,414,546
3	$1,285,200	$1,338,077

VII. SENSITIVITY ANALYSIS OF ALTERNATIVE PROBLEM SOLUTIONS

Cost sensitivity analysis is the method most often used in dealing with uncertainty in cost estimating and can show the sensitivity of total cost to particular components of a total cost model. The basic procedure of cost sensitivity analysis is to vary the assumptions regarding major parameters and then test the sensitivity of costs to these changed assumptions. Cost sensitivity, therefore, can be viewed as a method to aid decision makers when they are uncertain about the accuracy or the relative importance of information presented to them. As an aid to decision makers within COMSC, this technique of addressing uncertainty is applied to the major parameters of the lease rate factor, option to buy factor, salvage value, and the discount rate used to reflect the cost of capital.

A. LEASE RATE FACTOR SENSITIVITY ANALYSIS

As previously stated, the terms of long term container leases are determined by the state of the financial markets because the lessor views the transaction as just another form of long term financial investment. Thus, the lease rate factor goes up or down with the long term interest rates in the market. As long term interest rates rise thereby increasing the basic cost of leasing, alternative three becomes more and

more attractive while alternatives one and two maintain their relative order of preference when ranking alternatives using the fixed effectiveness at minimum cost criterion. However, as Table V illustrates, as the lease rate factor decreases from the fifteen per cent level assumed in the baseline analyses, alternative three is no longer the preferred option.

TABLE V

LEASE RATE FACTOR (LRF) COST SENSITIVITY SUMMARY

Alternative	15% LRF	14% LRF	13% LRF	12% LRF
1	$1,464,118	$1,372,056	$1,279,991	$1,187,929
2	$1,414,546	$1,322,484	$1,230,419	$1,138,357
3	$1,338,077	$1,338,077	$1,338,077	$1,338,077

Table V displays the total discounted cost of each alternative assuming various lease rate factors. At a lease rate factor of fourteen per cent and below, alternative two is the preferred option and, at all lease rate factors of thirteen per cent and below, the ranking of alternatives from the most to the least cost-effective becomes alternative two, one, and three respectively. Hence, the decision to negotiate either form of leasing arrangement versus negotiating a purchase is highly sensitive to a lease rate factor near the magnitude of fifteen per cent.

B. OPTION TO BUY FACTOR SENSITIVITY ANALYSIS

The baseline analyses utilized an option to buy factor of ten per cent of the container purchase price based on minimum

lease-defining provisions of 1982 tax legislation and assumed that COMSC would be able to negotiate the best possible terms for an option to buy feature. Because profit is a prime corporate motivator, cost sensitivity analysis of the option to buy factor below the minimum ten per cent required to advantageously use federal income tax laws as applied to leases is not germane. If the option to buy factor does change, it will move in the upward direction. Table VI, therefore, displays the total discounted cost of each alternative at various increasing option to buy factors.

TABLE VI

OPTION TO BUY FACTOR (OBF) COST SENSITIVITY SUMMARY

Alternative	10% OBF	15% OBF	18% OBF	20% OBF
1	$1,464,118	$1,464,118	$1,464,118	$1,464,118
2	$1,414,546	$1,443,823	$1,460,813	$1,472,380
3	$1,338,077	$1,338,077	$1,338,077	$1,338,077

As shown by Table VI, any increase in the option to buy factor above the baseline case increases the relative advantage of alternative three over alternative two. Thus, the lease versus purchase decision is rather insensitive to this factor. However, with an option to buy factor of twenty per cent or greater, alternative one is more attractive than alternative two, and the initial, baseline ranking of alternatives from most to least cost-effective changes to alternative three, one and two respectively. Hence, this factor does

influence the type of long term lease that should be negotiated if a leasing alternative were to be implemented when the option to buy factor is near the magnitude of twenty per cent. This influence stems primarily from the strong relationship between the option to buy factor and the assumed salvage value. As the option to buy cost begins to exceed the assumed salvage value, alternative one becomes the preferred leasing arrangement.

C. SALVAGE VALUE SENSITIVITY ANALYSIS

A salvage value of $300 was assumed throughout the baseline analyses. However, if this salvage value were to change, the question of what impact would it have on the ranking of alternatives quickly arises. Table VII examines this question by displaying the total discounted cost of each alternative at three different levels of salvage value.

TABLE VII

SALVAGE VALUE (SV) COST SENSITIVITY SUMMARY

Alternative	$0 SV	$300 SV	$600 SV
1	$1,464,118	$1,464,118	$1,464,118
2	$1,497,116	$1,414,546	$1,331,926
3	$1,420,697	$1,338,077	$1,255,457

As shown by Table VII, the salvage value can double or drop to zero and alternative three is still the preferred option. Hence, the lease versus purchase decision is highly insensitive to the salvage value. At the zero salvage value

level, however, alternative one is more desirable than alternative two, and the initial, baseline ranking of alternatives from most to least cost-effective changes to alternative three, one and two respectively. Therefore, the salvage value does influence the type of long term lease that should be negotiated if a leasing alternative were to be implemented when the salvage value approaches zero.

D. DISCOUNT RATE SENSITIVITY ANALYSIS

As required by DOD, the baseline analyses used a ten per cent discount rate to reflect the opportunity cost of capital. This rate was determined by what the DOD decision makers felt would be a fair and honest approximation of the present value rate for the aggregate of Defense investments. However, DOD policy does encourage using different discount rates as a supplement to an analysis based on the prescribed ten per cent rate. Table VIII summarizes the discounted cost of each alternative using various discount rates. The factors used in computing the discounted costs are based on continuous compounding of interest assuming uniform cash flows throughout each year of the ten year period.

As illustrated by Table VIII, a discount rate below the prescribed rate of ten per cent does not affect the initial, baseline ranking of alternatives. However, using a discount rate of twelve per cent does change the initial ranking of alternatives from most to least cost-effective to alternative

TABLE VIII

DISCOUNT RATE (DR) COST SENSITIVITY SUMMARY

Alternative	8% DR	10% DR	12% DR	14% DR
1	$1,582,141	$1,464,118	$1,360,537	$1,268,920
2	$1,523,267	$1,414,546	$1,318,799	$1,233,669
3	$1,334,487	$1,338,077	$1,339,219	$1,336,629

two, three and one, respectively. Additionally, at a discount rate of fourteen per cent, the ranking of alternatives changes again to alternative two, one and three with alternative three being the least cost-effective course of action. This relative ranking of alternatives established when using a discount rate of fourteen per cent is consistently maintained at increasingly higher discount rates. Hence, the decision to negotiate either form of leasing arrangement versus negotiating a purchase is highly sensitive to a discount rate in the range of ten to fourteen per cent.

E. SENSITIVITY ANALYSIS SUMMARY

Sensitivity analysis of major parameters was performed with the purpose of alerting decision makers to their relative importance. As indicated by the sensitivity analyses performed, decision makers must be aware of the significant changes in the ranking of alternatives caused by relatively minor variations in the lease rate factor used to compute basic leasing costs and in the discount rate used to reflect the cost of capital. Additionally, decision makers should

note the more subtle changes caused by varying the option to buy factor and salvage value that occur in ranking alternatives one and two within the more narrow consideration of executing some form of leasing arrangement.

As a final note, sensitivity analysis was not performed on the purchase price parameter because of the proportional nature of the total cost model. Because of this proportionality of costs to the purchase price, the relative ranking of alternatives would not change for a reasonable range of changes in the purchase price.

VIII. CONCLUSIONS AND RECOMMENDATIONS

The goal of this analysis has been to determine the most cost-effective method of acquiring standard steel containers to support COMNAVSUPSYSCOM's four Pacific logistics pipelines. In trying to achieve this goal, explicit assumptions have been made concerning the alternatives being evaluated. Hence, the conclusions and recommendations presented here are necessarily based upon these assumptions. It is recognized and emphasized that the results of this analysis can significantly change by varying these underlying assumptions. However, in the course of obtaining these results, a complete framework for analysis has been developed and presented. Therefore, any additional alternatives, such as the leasing of required containers for a period of five years followed by a purchase, may be evaluated within this same framework.

Using the fixed effectiveness at minimum cost criterion, the baseline analysis of the alternatives indicates that alternative three, negotiating a purchase, is the most cost-effective course of action and should be implemented. However, as discovered in the sensitivity analysis, the decision of lease versus purchase is highly sensitive to the specific lease rate factor of fifteen per cent that would most likely be used to compute basic leasing costs in today's container leasing environment. Because alternative two,

negotiating a long term lease with an option to buy, becomes the most cost-effective course of action at lease rates of fourteen per cent and lower, the decision to lease with an option to buy or to negotiate a purchase becomes a function of the behavior of the long term financial investment market upon which the lease rate factor is based and of COMSC's skills in negotiating a lease rate. If the state of the long term financial investment market combines with COMSC's negotiating expertise to obtain a lease rate of fourteen per cent or lower, then leasing with an option to buy is the preferred course of action that should be implemented.

When ranking lease cost alternatives to achieve a fixed level of effectiveness, DOD policy is to select the alternative with the lowest discounted cost because it implies that resources are allocated more efficiently in the sense that fewer total resources must be diverted to satisfy the requirement at hand. Additionally, DOD requires future cash flows to be discounted at a ten per cent rate. When using this required rate, alternative three, negotiating a purchase, is the most cost-effective alternative that should be implemented. However, as illustrated in the sensitivity analysis, when the decision maker considers slightly higher and perhaps more realistic opportunity costs of capital, alternative two, negotiating a long term lease with an option to buy, again becomes the preferred course of action that should be implemented. Hence, the decision of leasing

with an option to buy versus negotiating a purchase can become a function of determining the appropriateness of applying the DOD aggregate investment discount rate of ten per cent because of its prevalence in past DOD practice.

When reviewing the evaluated alternatives, it is evident that alternative three, negotiating a purchase, requires a large initial outlay in year one and depends on a residual salvage value in year ten for its superiority. Therefore, there is a degree of risk associated with alternative three. This risk can be roughly estimated by computing a pay back period based on the difference in annual cash flows between negotiating a purchase and negotiating a long term lease with an option to buy. This computed pay back period of 6.7 years indicates that alternative three is superior to alternative two only after sixty-seven per cent of the original lease period and economic life of a container has expired.

Because of the sensitivity of costs to the lease rate factor and the discount rate used to reflect the opportunity cost of capital as well as the risk associated with alternative three, the superiority of negotiating a purchase over negotiating a long term lease with an option to buy is tenuous. Hence, it is recommended that COMSC aggressively pursue negotiating a long term lease with an option to buy in an attempt to achieve a lease rate factor of fourteen per cent or lower. If COMSC is not able to obtain a desirable lease rate of fourteen per cent or less, COMSC's efforts

should then be directed at negotiating a purchase. By following this course of action, COMSC will have utilized the viable avenues available to maintain the level of container service necessary to support COMNAVSUPSYSCOM's current readiness posture on its four Pacific logistics pipelines at minimum cost.

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